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Technology Evaluation Report

HYDROTECHNICS IN SITU FLOW SENSOR

National Risk Management Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268



NOTICE

The information in this document has been funded by the U.S. Environmental Protection Agency (EPA) under Contract No. 68-C5-0037 to Tetra Tech EM Inc. It has been subjected to the Agency's peer and administrative reviews and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute an endorsement or recommendation for use.

FOREWORD

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory (NRMRL) is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites and groundwater; and prevention and control of indoor air pollution. The goal of this research effort is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication has been produced as part of NRMRL's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

ABSTRACT

The U.S. Environmental Protection Agency (EPA) Superfund Innovative Technology Evaluation (SITE) Program evaluated performance of HydroTechnics, Inc. flow sensors in measuring the three-dimensional flow pattern created by operation of the Wasatch Environmental, Inc. (WEI) groundwater circulation well (GCW). The GCW is a dual-screened, in-well air-stripping system designed to remove volatile organic compounds (VOC) from groundwater. Operation of the GCW creates a groundwater flow pattern that forms a three-dimensional regime known as a “circulation cell.” EPA’s evaluation of the GCW circulation cell involved use of in situ groundwater velocity flow sensors that were developed at Sandia National Laboratories and manufactured by HydroTechnics, Inc.

This Technology Evaluation Report (TER) documents and summarizes the findings of EPA’s evaluation of HydroTechnics’ flow sensors. The flow sensors are in situ instruments that use a thermal perturbation technique to directly measure the velocity of groundwater flow in unconsolidated, saturated, porous media. The manufacturer claims that the flow meter can measure horizontal and vertical flow rates and direction in the range is 0.01 to 2.0 feet per day (ft/day) (0.3 to 60.96 centimeter per second [cm/s]).

The GCW is a patented system manufactured by WEI and was demonstrated at Cape Canaveral Air Station (CCAS) by the U.S. Air Force Center for Environmental Excellence (AFCEE). AFCEE conducted a comprehensive evaluation of the GCW, including contaminant mass removal rates, groundwater dye tracer studies, and numerical modeling. Demonstration data collected by AFCEE are documented separately in “Groundwater Circulation Well Technology Evaluation at Facility 1381, Cape Canaveral Air Station, Florida Technology Summary Report” (Parsons 2001).

The primary conclusions of EPA’s evaluation of the HydroTechnics flow sensors include:

- During GCW operation, the groundwater velocities measured by all seven sensors increased by more than 0.1 ft/day, indicating that (1) the sensors were within the circulation cell established by the GCW, and (2) the horizontal extent of groundwater circulation was greater than 15 feet. Flow direction data further support the establishment of a circulation cell and that all the flow sensors are within the horizontal extent of groundwater circulation cell.
- The demonstration data suggest that the flow sensors are responsive to changes in groundwater flow conditions and can be used to help define and evaluate the three-dimensional flow patterns.

This report is available from www.epa.gov/ORD/SITE/reports.html. Printed copies can be obtained from National Service Center for Environmental Publications in Cincinnati, Ohio, at (800) 490-9198.

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ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AFCEE	Air Force Center for Environmental Excellence
bgs	Below ground surface
°C	Degrees Celsius
CCAS	Cape Canaveral Air Station
cm/s	Centimeters per second
DC	Direct current
DCE	Dichloroethene
DFT	Dipole flow test
EPA	U. S. Environmental Protection Agency
ft/day	Feet per day
GCW	Groundwater circulation well
gpm	Gallons per minute
HP	Horsepower
KSC	John F. Kennedy Space Center
msl	Mean sea level
NAPL	Nonaqueous phase liquids
NRMRL	National Risk Management Research Laboratory
ORD	Office of Research and Development
OSWER	Office of Solid Waste and Emergency Response
Parsons	Parsons Engineering Science, Inc.
psi	Pounds per square inch
PVC	Polyvinyl chloride
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RPD	Relative percent difference
SARA	Superfund Amendments and Reauthorization Act
SITE	Superfund Innovative Technology Evaluation
TCE	Trichloroethene
TEP	Technology Evaluation Plan
TER	Technology evaluation report
Tetra Tech	Tetra Tech EM Inc.
VOC	Volatile organic compound
WEI	Wasatch Environmental, Inc.
µg/L	Micrograms per liter

CONVERSION FACTORS

	<i>To Convert From:</i>	<i>To:</i>	<i>Multiply By:</i>
Length:	inch	centimeter	2.54
	foot	meter	0.305
	mile	kilometer	1.61
Area:	square foot	square meter	0.0929
	acre	square meter	4,047
Volume:	gallon	liter	3.78
	cubic foot	cubic meter	0.0283
	cubic foot	gallon	7.48
	cubic foot	cubic centimeter	28,317
Mass:	pound	kilogram	0.454
Temperature:	($F - 32$)	C	0.556
Time	days	minutes	1440

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